IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re: Application of Naoko SAWATARI, Masato OKABE and Hideo HAMA

Serial No.: 10/587,069

Filed: July 21, 2006

For: LIQUID CRYSTAL DISPALY

DECLARATION UNDER 37 CFR 1.132

Honorable Commissioner of Patents and Trademarks,

P. O. Box 1450, Alexandria, VA 22313-1450

Sirs:

I, Naoko SAWATARI, a Japanese citizen, residing at c/o DAI NIPPON PRINTING CO., LTD., 1-1, Ichigaya-kagacho 1-chome, Shinjuku-ku, Tokyo 1628001, Japan, hereby declare and state that I am one of the inventing members of the inventions disclosed in the above-entitled patent application.

I declare that I graduated from Department of Applied Chemistry, Graduate School of Engineering, Kansai University in March 2003 and that I have been employed by DAI NIPPON PRINTING CO., LTD. (assignee of the present application) from 2003 and I am now engage in AD Research Laboratory, Research & Development Center.

I also declare that I have read all of the documents concerning the above-entitled patent application, and am familiar with the contents of the present inventions in this application.

I further declare that the following experiment was conducted by myself and that the result of the experiment is all true and correct to the best of my own knowledge.

[Experiment]

Experiment was conducted in accordance with the following items.

1. Object of Experiment
2. Experiment
3. Evaluation
4. Conclusion

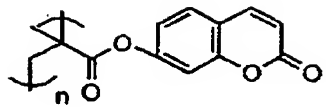
1. Object of Experiment

Experiment was conducted regarding inventions described in amended claims of U.S. Patent Application Serial No. 10/587,069 (hereinafter, the present application). The experiment was conducted to show, when the constituent material of the respective photo alignment layer has a different composition from each other, effects of suppressing the generation of double domains can be obtained so that mono-domain alignment of the ferroelectric liquid crystal can be obtained. More specifically, in liquid crystal display comprising a ferroelectric liquid crystal having no smectic A phase in a phase series thereof, displayed condition was examined in each case: the constituent material of the respective photo alignment layer has a different composition from each other; and the constituent material of the respective photo alignment layer has the same composition.

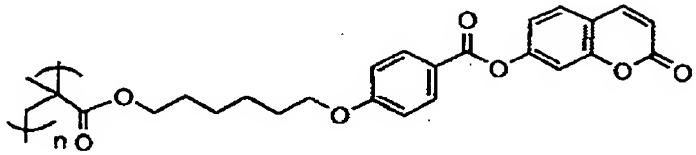
2. Experiment

Two glass substrates each coated with ITO were cleaned, and an alignment layer was formed on each of the two substrates.

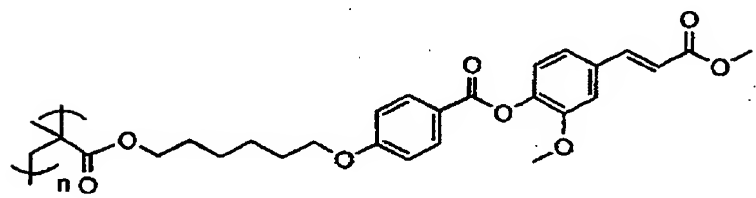
Using the following compounds A-D and polyimide "RN1199" produced by NISSAN CHEMICAL INDUSTRIES, LTD., the alignment layers were formed as follows.



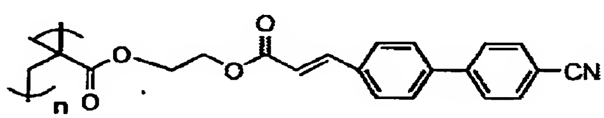
A



B



C



D

When using the compounds A-D, a 2% by weight solution of one of the compounds A-D dissolved in a cyclopentanone was spin coated on each glass substrate coated with ITO by the 4,000 rpm rotational frequency for 30 seconds. The substrate spin-coated was dried at 180°C in an oven for 10 minutes, and then polarized ultraviolet rays were radiated onto the substrate at 100 mJ/cm^2 from an angle of 30° to the substrate face at 25°C.

When using "RN1199", except that the "RN1199" was exposed by a 10 J/cm^2 polarized ultraviolet ray, they were spin coated and dried under the above-mentioned conditions.

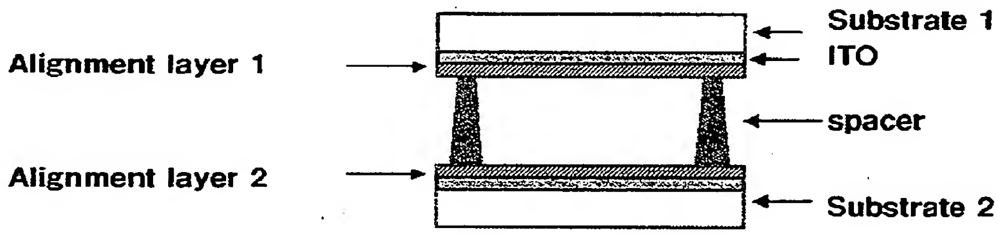
Spacers of 1.5 μm size were sprayed onto one of the substrates, and a sealing material was applied onto the other substrate with a seal dispenser.

The substrates were arranged face to face and in parallel to the radiation direction of the polarized ultraviolet rays, and then, thermally assembled. Thus, test cells of one inch

were produced.

As the ferroelectric liquid crystal, an "R2301" (manufactured by Clariant (Japan) K.K.) was used. The liquid crystal was attached to the upper of an injecting port thereof, and an oven was used to perform the injection of the liquid crystal at a temperature higher by 10 to 20°C than the phase transition temperature between nematic and isotropic phases. The temperature was slowly returned to room temperature.

-Configuration of the Cells-



The experiment was conducted for the following combinations of the alignment layers using compounds A-D and "RN1199".

	EX1	EX2	EX3	EX4	EX5	EX6
alignment layer 1	A	A	A	A	B	C
alignment layer 2	B	C	D	RN1199	C	D

	Comparative Ex1	Comparative Ex2	Comparative Ex3	Comparative Ex4
alignment layer 1	A	B	C	D
alignment layer 2	A	B	C	D

3. Evaluation

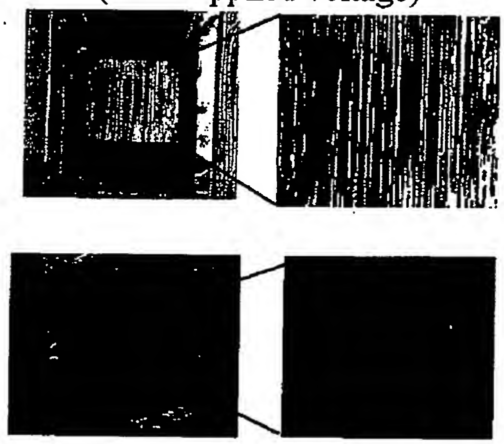
Aluminum electrodes were connected to the produced test cells, and the cells were sandwiched between polarizing plate. The alignment condition was observed under crossed nicols. As shown below, the voltage (5V) was applied to the aluminum electrodes and the photographs were taken.

Evaluation of Double Domain defect

Picture of test cell
(when applied voltage)

Double domain

Mono domain



The photographs taken for Examples 1-6 and Comparative Examples 1-4 are attached.

For those cells where both upper and lower alignment layers are constituted of the same material, double domain (display of black and white stripes) occurred. On the other hand, for those cells where upper and lower alignment layers are constituted of different materials from each other, mono domain alignment (display of black only) was obtained.

4. Conclusion

From the above described results of this experiment, in liquid crystal display comprising a ferroelectric liquid crystal having no smectic A phase in a phase series thereof, it is proved that mono domain alignment is obtained when the constituent material of the respective photo alignment layer has a different composition from each other.

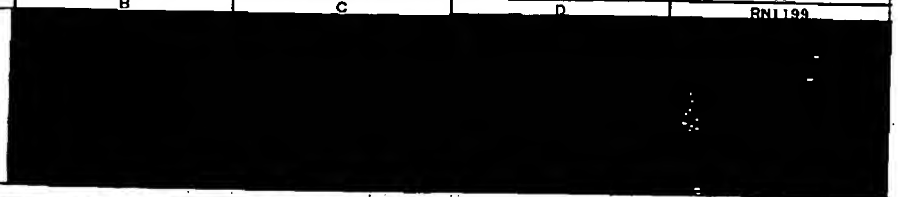
I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

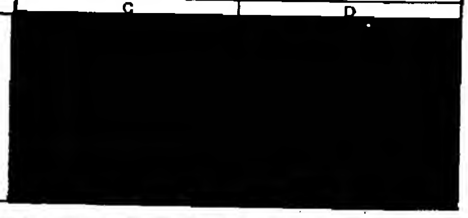
Dated this 1st day of December, 2008

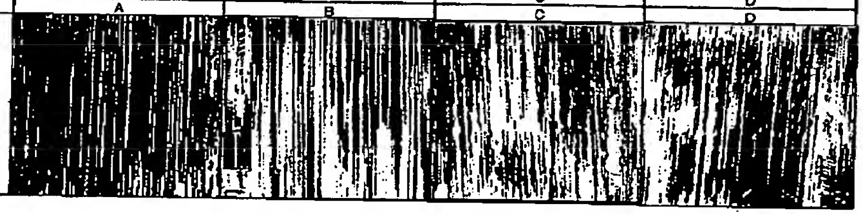
Naoko Sawatari

Naoko SAWATARI

Experimental Data

Example number	Example 1	Example 2	Example 3	Example 4
Alignment layer 1	A	A	A	A
Alignment layer 2	B	C	D	RN1199
Picture of test cell				

Example number	Example 5	Example 6
Alignment layer 1	B	C
Alignment layer 2	C	D
Picture of test cell		

Example number	Comparative Ex1	Comparative Ex2	Comparative Ex3	Comparative Ex4
Alignment layer 1	A	B	C	D
Alignment layer 2	A	B	C	D
Picture of test cell				

1. In relation to Prior Art

Electric Field Induced Technique

1) US 2006/0244895 A1 (assignee of the application whose priority is claimed: Fujitsu Limited)

2) US 6,614,491 B2 (assignee: Toshiba Corporation)

3) US 2004/0119931 A1 (assignee: LG. Philips LCD Co., Ltd.)

The electric field induced technique, which uses DC voltage during cooling process, is described, for example, in the above-mentioned references. Since assignees of these references differ from each other, it is obvious that, when the present application was filed, the electric field induced technique was a well-known method to resolve double domain issues.

Recognizing the problems concerning the electric field induced technique, these references are just improving the electric field induced technique. Thus, it is easily deduced that, when the present application was filed, there was no alternate practical means to resolve double domain issues other than the electric field induced technique.

Shown below are descriptions, found in the above-mentioned references, concerning the electric field induced technique and a ferroelectric liquid crystal having no smectic A phase in a phase series thereof.

1) US 2006/0244895 A1
Claim 1
Paragraph 0010 and 0012

In paragraph 0010 of this reference, "the average molecular axis LCMA can have two states of different directions" means the same as "double domain" in the specification of the present application.

2) US 6,614,491 B2
Claims 1 and 11
Column 1, lines 43-62

3) US 2004/0119931 A1
Claims 1-7
Fig. 3

Paragraph 0014-0017

In Fig. 3 of this reference, "BISTABLE" means the same as "double domain" in the specification of the present application, and "MONOSTABLE" means the same as "mono domain" in the specification of the present application.

In this reference, terms are used in different ways from the specification of the present application.

2. Comparison between Present Invention and Above References

The electric field induced technique method has problems that the alignment of the liquid crystal is disturbed, when the temperature thereof is raised again to a temperature not lower than the phase transition temperature, unless the electric field induced technique is carried out again. Also, there is a problem that the alignment is disturbed in regions where no electric field acts between pixel electrodes.

The present invention aims to provide a means to resolve the double domain issues without using the electric field induced technique. In other words, the present invention aims to provide liquid crystal displays which can give mono domain alignment and which are excellent in alignment stability so that the alignment thereof can be maintained even if the temperature of the liquid crystal is raised to the phase transition point or higher.

Not by using the electric field induced technique, the present inventors have found out that alignment defects of double domain, that are peculiar to a ferroelectric liquid crystal having no smectic A phase in a phase series thereof, can be suppressed and mono domain alignment can be obtained. That is, aside from the electric field induced technique, the present inventors have found a new way of obtaining mono domain alignment of the ferroelectric liquid crystal having no smectic A phase in a phase series thereof.

In the present invention, a photo alignment layer is provided on each opposite faces of upper and lower substrates and the photo alignment layers are made of materials different from each other. Thereby, generation of alignment defects such as double domain is restricted and mono-domain alignment of the ferroelectric liquid crystal is obtained. It is not clear as to the reasons of why the using of materials different in composition as the constituent materials of the photo alignment layers can give mono-domain alignment, but it is thought to be based on the difference in the interaction between the upper photo alignment layer and the ferroelectric liquid crystal and between the lower photo alignment layer and the ferroelectric liquid crystal.

Further, since the present invention can align the ferroelectric liquid crystal

without using the electric field induced technique, the problem in the electric field induced technique that alignment disturbance caused by the rising in the temperature to the phase transition point or higher is less likely to cause so that the present invention shows excellent alignment stability.

For the reasons described above, the above-mentioned references describing inventions related to the electric field induced technique do not suggest the present invention. Further, the present invention is not obvious from the above-mentioned references describing inventions related to the electric field induced technique.

"R2301" (manufactured by Clariant (Japan) K.K.)

In Examples and Comparative Examples of the present specification, "R2301" (manufactured by Clariant (Japan) K.K.) is used as a ferroelectric liquid crystal.

Thus, documents are submitted to show that "R2301" has no smectic A phase in a phase series thereof.

In a document from Clariant (Japan) K.K dated April 16, 2002, the following characteristics of "R2301" are described: applied wave form for TV measurement (page 1); TV characteristics for CDR-FLC and response time for CDR-FLC (page 2); and temperature dependence of response time for CDR-FLC (page 3).

The phase series of "R2301" is not described in the document from Clariant (Japan) K.K. However, in a document from AZ Electronic Materials dated October of 2005, the phase series of "R2301" is described (page 12).

The company's name for Clariant (Japan) K.K was altered to AZ Electronic Materials in 2004.

In the document (pages 12-14) from AZ Electronic Materials, the followings, that are described in the document from Clariant (Japan) K.K, are described: applied wave form for TV measurement (page 1); TV characteristics for CDR-FLC and response time for CDR-FLC (page 2); and temperature dependence of response time for CDR-FLC (page 3).

Therefore, it is clear that "R2301" described in the document from AZ Electronic Materials is the same as "R2301" described in the document from Clariant (Japan) K.K.

The phase series of "R2301" is described in the document (page 12) from AZ Electronic Materials as follows:

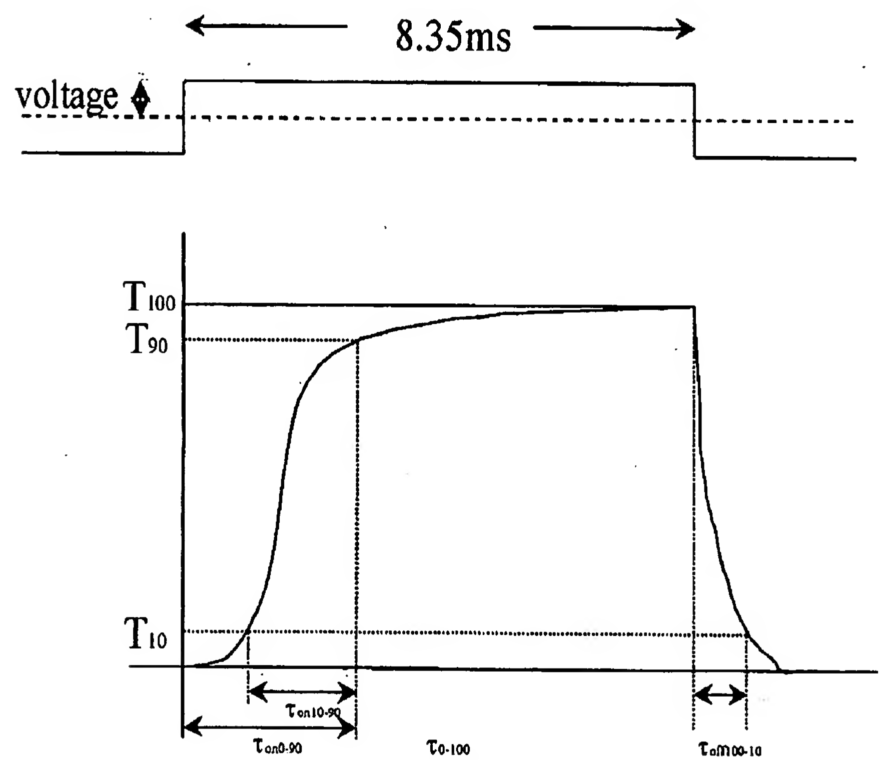
I (Isotropic) 86.8-84.8 (℃) Ch* (Cholesteric) 64.7 (℃) Sc* (Chiral Smectic C)

From the above-mentioned description, it is clear that "R2301" has no smectic A phase (SmA) in a phase series thereof.

Clariant
Ferroelectric Liquid Crystals / FELIX®

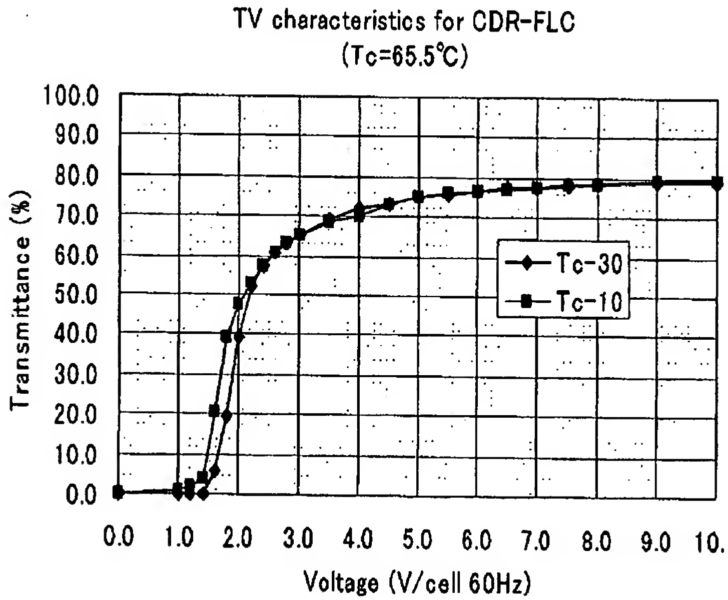
R2301 技術資料
2002.04.16

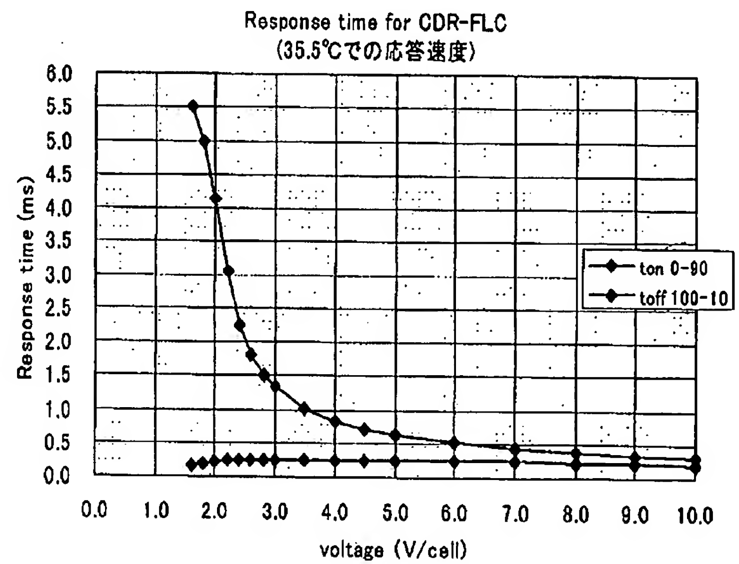
Applied wave form for TV measurement



Clariant
Ferroelectric Liquid Crystals
/ FELIX

R2301 技術資料
2002.04.16





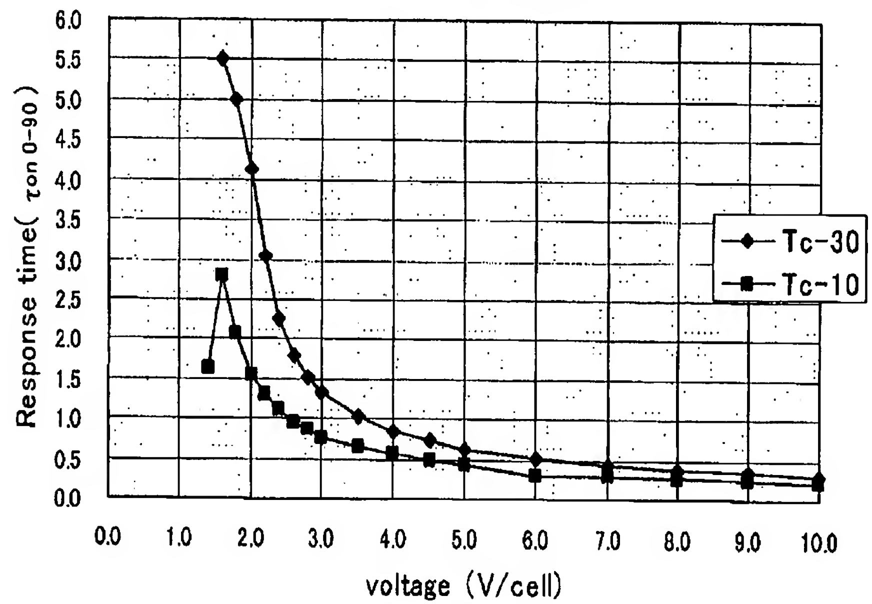
Clariant

Ferroelectric Liquid Crystals® / FELIX

R2301 技術資料

2002.04.16

Temperature deendence of Response time for CDR-FLC
(55.5℃と35.5℃の応答速度の比較)



Clariant

Ferroelectric Liquid Crystals®
/ FELIX

R2301 技術資料
2002.04.16

	測定温度 (℃)		
	15.5	35.5	55.5
黒状態の透過率 (%)	0.23	0.20	0.19
5V@60Hz 矩形波印可時の透過率(%)	87.2	81.2	82.4
5V@60Hz 矩形波印可時の0→90%応答速度 (msec)	1.60	0.96	0.61
5V@60Hz 矩形波印可時の100→10%応答速度 (msec)	0.55	0.28	0.19
±5V@60Hz 矩形波印可時のコーン(ｽｲｯﾁﾝｸﾞ)角	46.3	44.1	44.0
±10V@60Hz 矩形波印可時のコーン(ｽｲｯﾁﾝｸﾞ)角	52.3	51.7	50.2

*透過率は、8msec後を測定
** 測定セルは、配向膜SE7992のｱﾝﾁﾗﾋﾞﾝｸﾞｾﾙを使用

単安定型強誘電性液晶

Monostable-FLC for Active Matrix displays

October 2005

AZ Electronics Materials (Germany) GmbH
T.Nonaka

AZ Electronic Materials

目次

AZ Electronic Materials

CDR-FLC (Continuous director rotation mode)

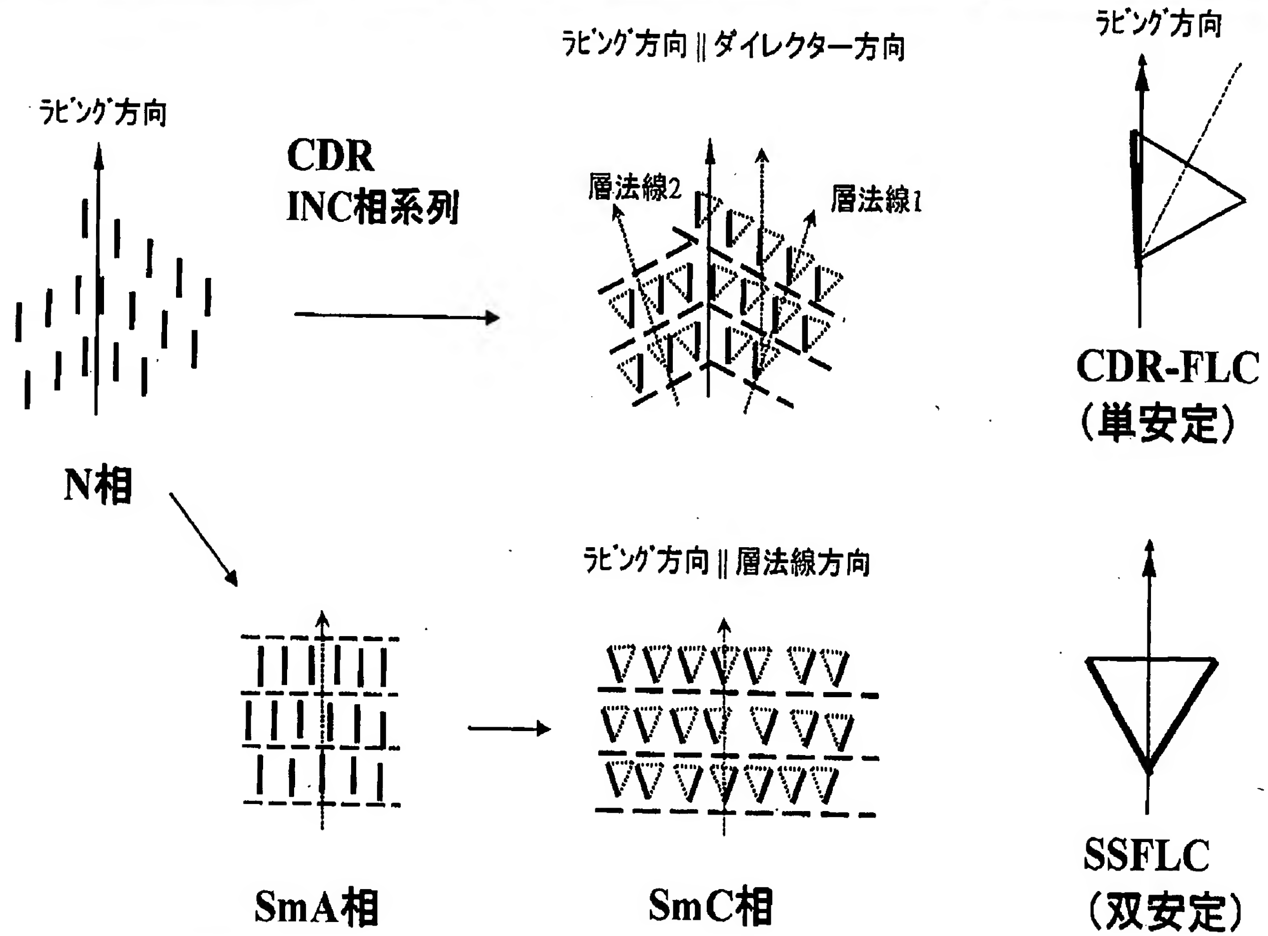
CDR-FLCの特徴

- 低自発分極によりa-Si TFT駆動が可能
- 高速応答（<1 mS, Field Sequential-color 表示可能）
- インパルス駆動表示
- 低電圧駆動

AZ Electronic Materials

3

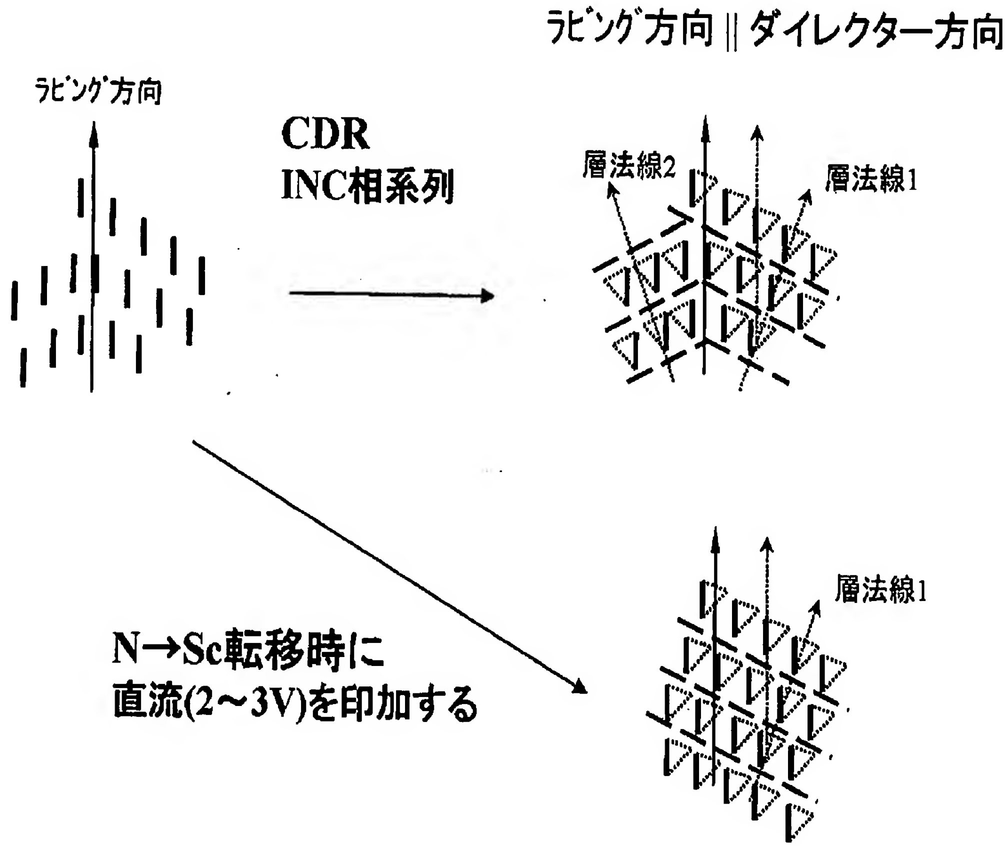
CDR-FLCの相系列と配向



AZ Electronic Materials

4

CDR-FLCの配向方法



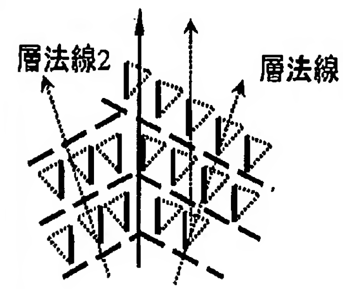
AZ Electronic Materials

5

CDR-FLCの配向状態

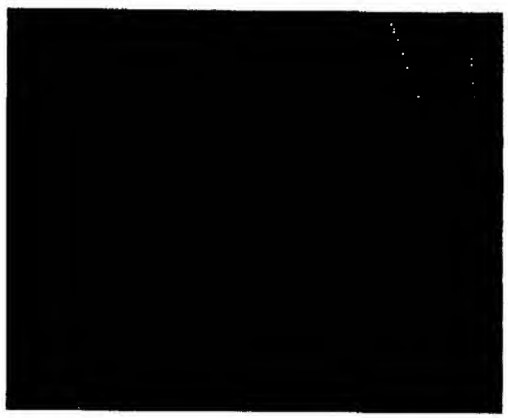
DC 無印加

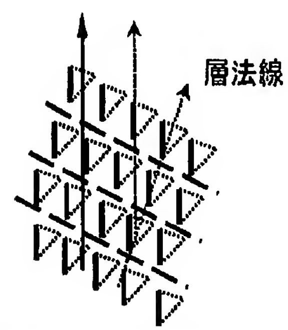
2つのドメイン



+3V DC 印加

配向

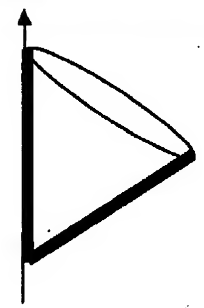




AZ Electronic Materials

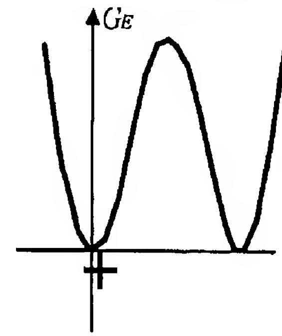
6

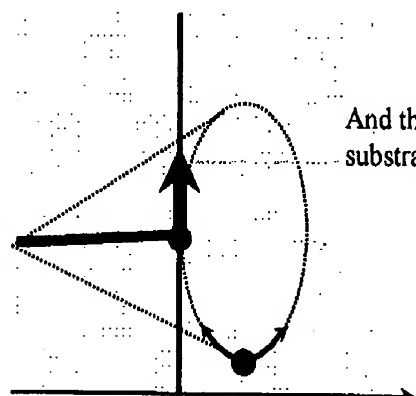
CDR 単安定化の機構



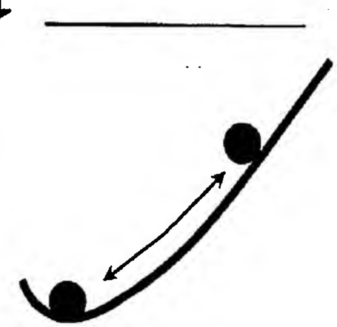
1層方向が選択される
(ラビング方向が安定化)

↓





And the stable position is also parallel to the substrates.

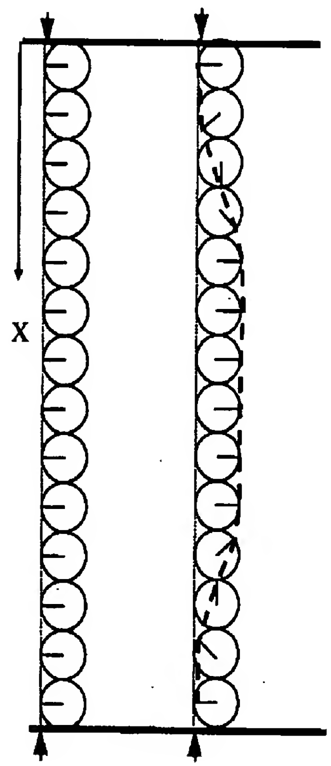


中間位置の不安定性とPs*E torqueが釣りあうことにより
電圧により中間調の制御が可能

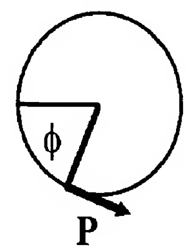
AZ Electronic Materials

7

CDR-FLCの電気光学特性



界面固定



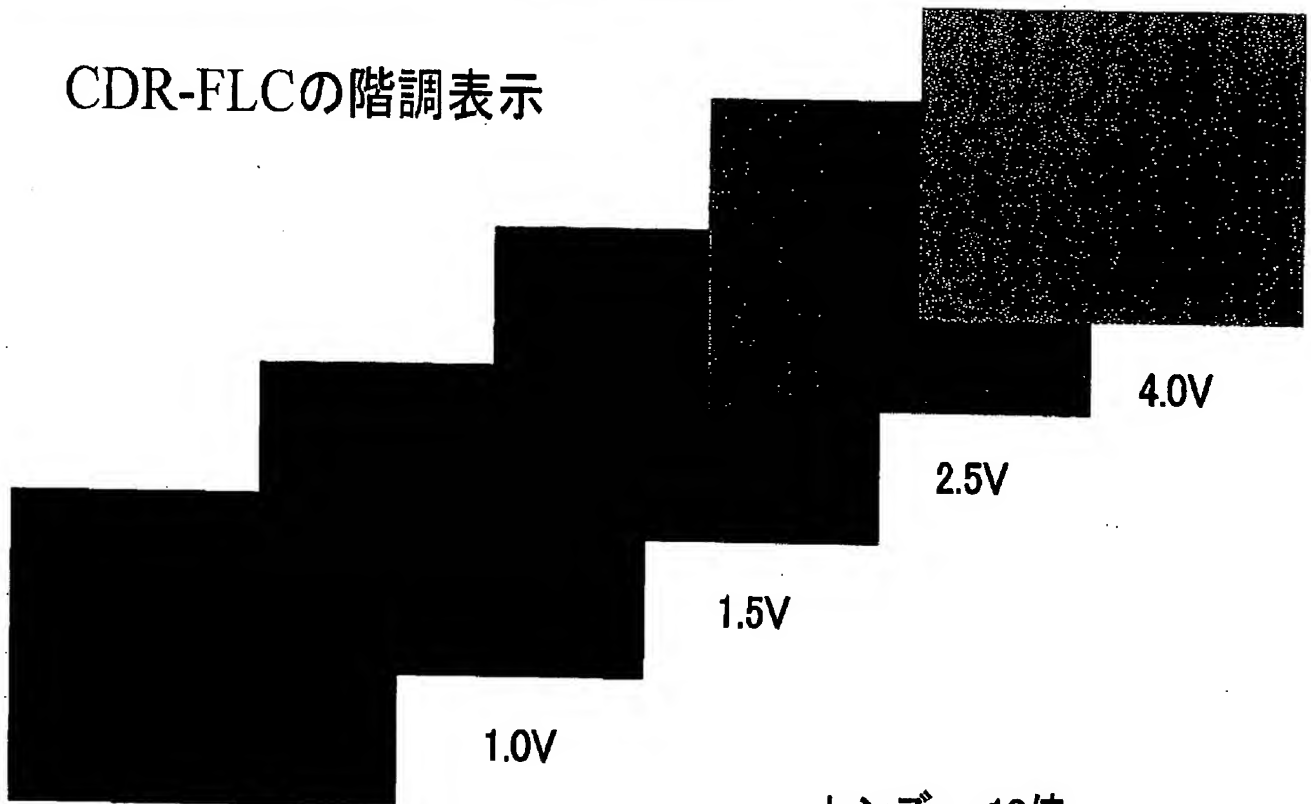
- 黒い暗状態
- アンカリングと駆動電場の拮抗による安定した中間調
- 原理的に履歴が存在しない(界面固定ドメインレス)
- 小さいVTの温特
- 厚めのギャップが可能

AZ Electronic Materials

8

CDR-FLCの中間調表示

CDR-FLCの階調表示

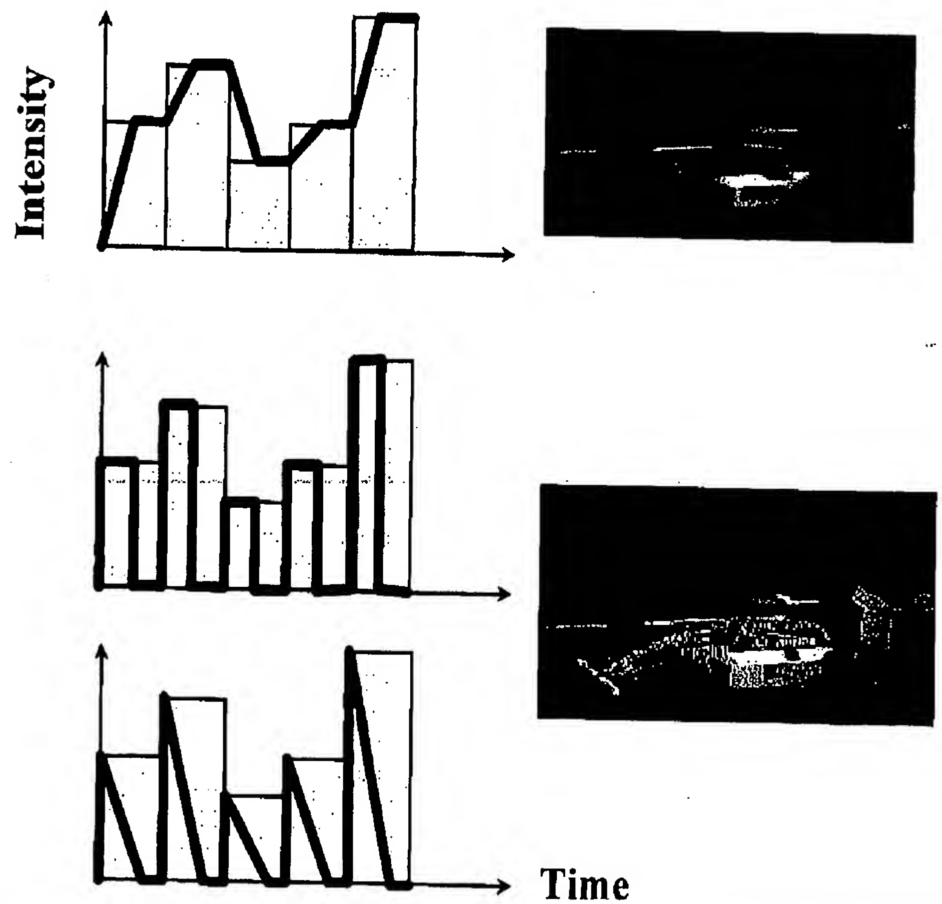


レンズ :x10倍
露出　: 2.0秒
セル厚: 1.4μm

AZ Electronic Materials

9

CDR-FLC インパルス駆動と動画表示特性



TFT-TN
blurry image
静止画向き

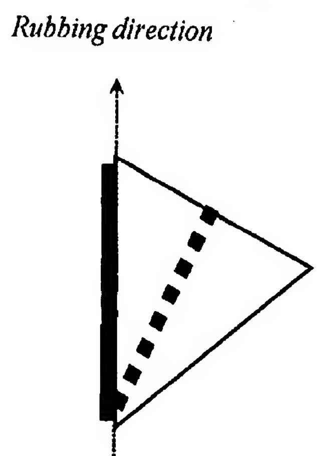
TFT-CDR
sharp image

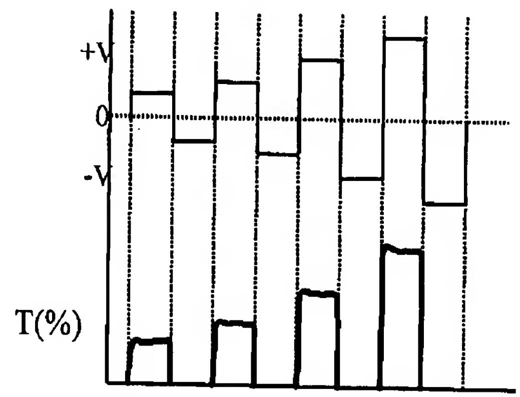
Cathode-Ray-Tube
sharp image

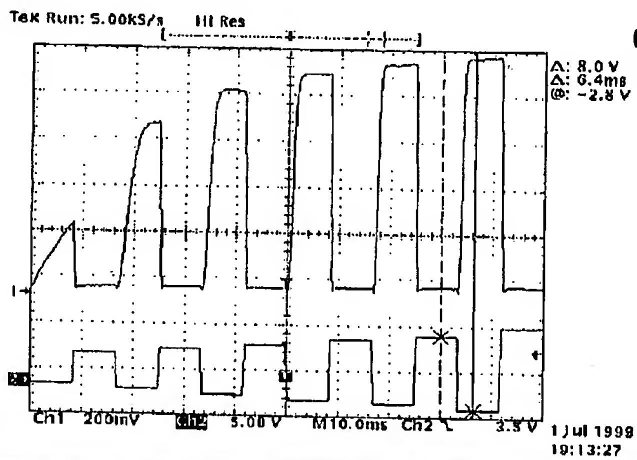
AZ Electronic Materials

10

CDR-FLCのスイッチング







CDRは、その特性からバックライトの変調なしでImpulse駆動が可能である

AZ Electronic Materials

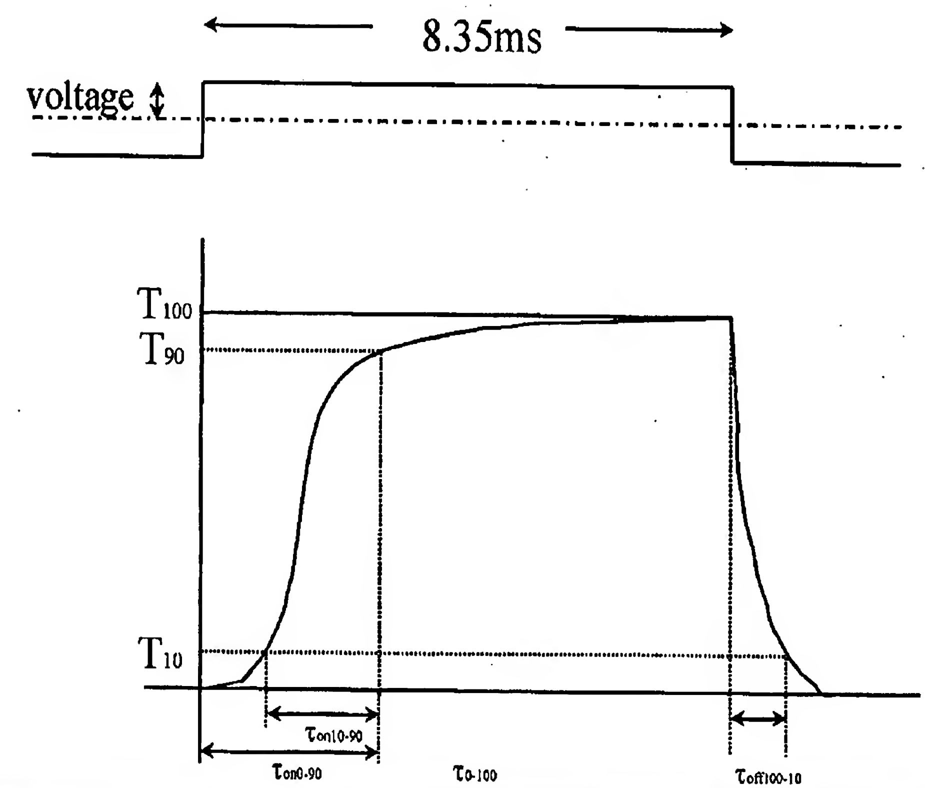
AZ, the AZ logo, BARLi, Aquatar, nLOF, Kwik Strip, Klebosol, and Spinfil are registered trademarks and AX, DX, HERB, HiR, MIR, NCD, PLP, Signiflow,

11

CDR-FLC (R2301)

CDR-FLCの特性 (R2301)

Phase transition I 86.8 - 84.8 Ch* 64.7 Sc* Ps=3.5nC/cm2 (at room temperature)

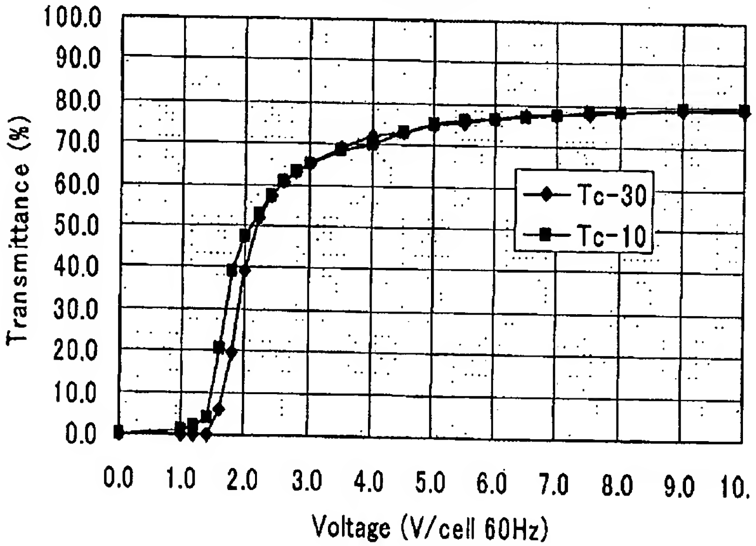


AZ Electronic Materials

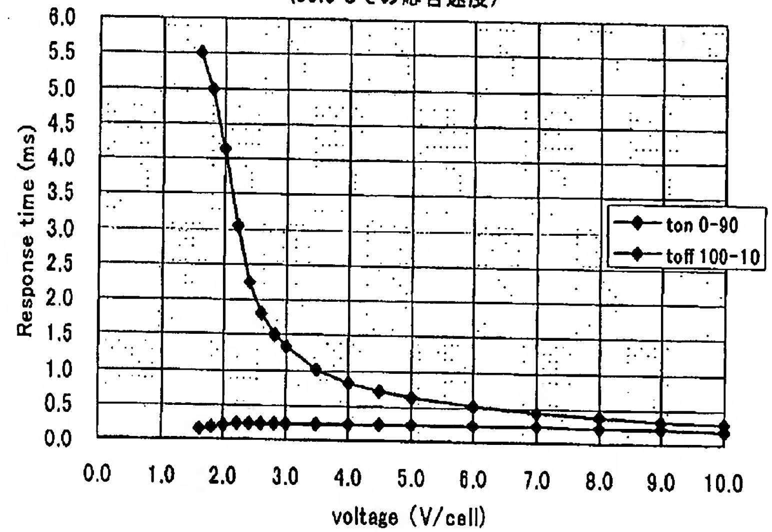
12

R2301の応答速度(電圧依存性)

TV characteristics for CDR-FLC
(Tc=65.5℃)



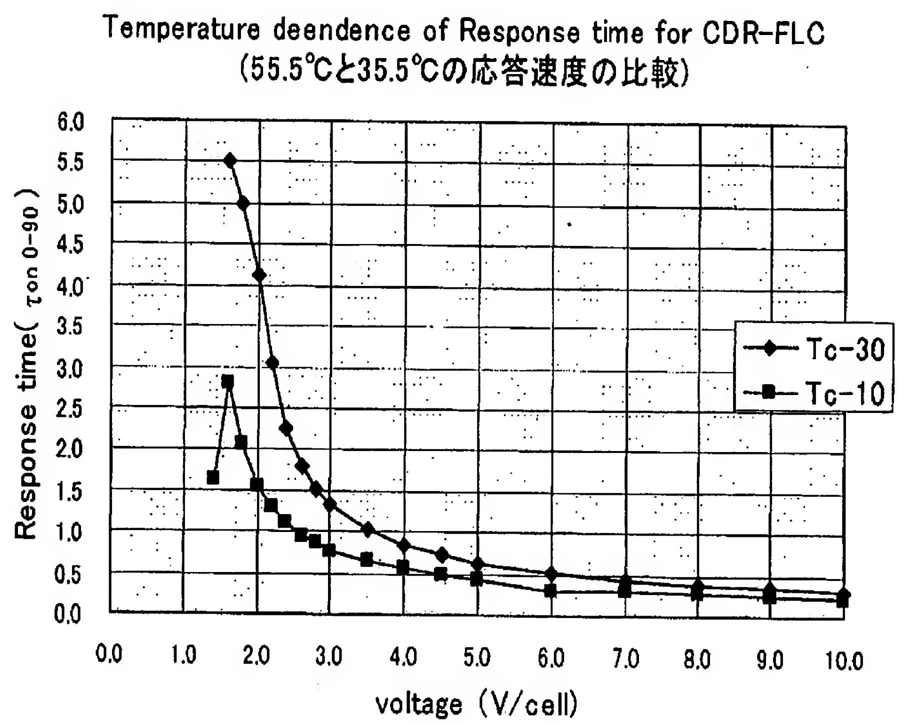
Response time for CDR-FLC
(35.5℃での応答速度)



AZ Electronic Materials

/3

R2301の応答速度(温度依存性)



AZ Electronic Materials

14

R2301の電気光学特性(まとめ)

	測定温度(°C)		
	15.5	35.5	55.5
黒状態の透過率 (%)	0.23	0.20	0.19
5V@60Hz 矩形波印可時の透過率(%)	87.2	81.2	82.4
5V@60Hz 矩形波印可時の0→90%応答速度 (msec)	1.60	0.96	0.61
5V@60Hz 矩形波印可時の100→10%応答速度 (msec)	0.55	0.28	0.19
±5V@60Hz 矩形波印可時のコーン(ｽｲｯﾁﾝｸﾞ)角	46.3	44.1	44.0
±10V@60Hz 矩形波印可時のコーン(ｽｲｯﾁﾝｸﾞ)角	52.3	51.7	50.2

*透過率は、8msec後を測定
** 測定セルは、配向膜SE7992のｱﾝﾁﾗﾋﾞﾝｸﾞｾﾙを使用

AZ Electronic Materials

15

AM-CDR-FLCの応用例

CDR-FLCの特徴:

- アナログ中間調
- 高速性
- 広視野角
- 低Ps
- 広い保存・駆動温度範囲

多彩な表示方式:

- 高速動画表示
- a-Si TFTによる駆動
- 非ホールド表示
  (インパルス駆動)
- フィールドシーケンシャル
- プロジェクション

アプリケーション例:

- Multimedia Display
- 高品位・中サイズ
  PC & HDTVモニター
- マイクロディスプレー
- プロジェクション TV
- 高精細ディスプレー

AZ Electronic Materials

16

参考文献

Novel ferroelectric liquid crystal mode for active matrix liquid crystal display using cholesteric-chiral smectic C phase transition material. Asao, Yasufumi; Togano, Takeshi; Terada, Masahiro; Moriyama, Takashi; Nakamura, Shinichi; Iba, Jun. Canon Research Center, Core Technology Development Headquarters, Canon Inc., Kanagawa, Japan. Jpn. J. Appl. Phys., Part 1 (1999), 38(10), 5977-5983.

Material characteristics of an active matrix LCD based upon chiral smectics. Nonaka, Toshiaki; Li, Ji; Ogawa, Ayako; Hornung, Barbara; Schmidt, Wolfgang; Wingen, Rainer. Clariant Japan K.K, NBD Laboratory/FLC group, Shizuoka, Japan. Liq. Cryst. (1999), 26(11), 1599-1602.

17